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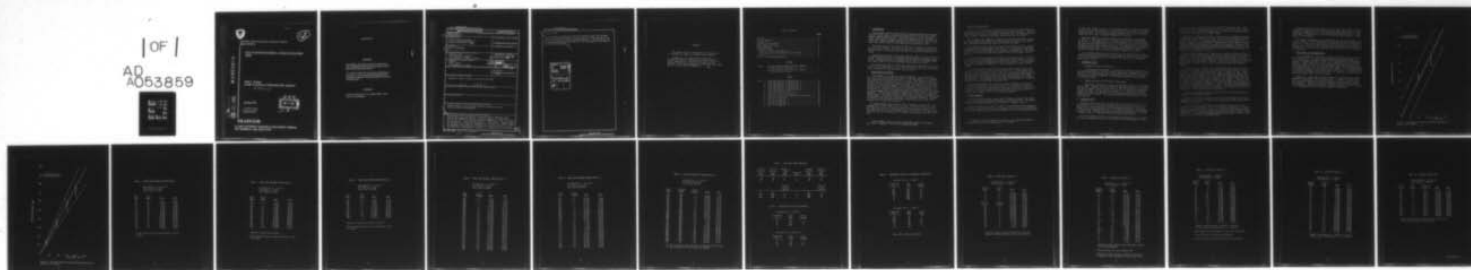
ARMY ELECTRONICS RESEARCH AND DEVELOPMENT COMMAND FO--ETC F/G 18/4
TESTS OF NEUTRON DOSIMETER, ADVANCED DEVELOPMENT MODEL, (U)
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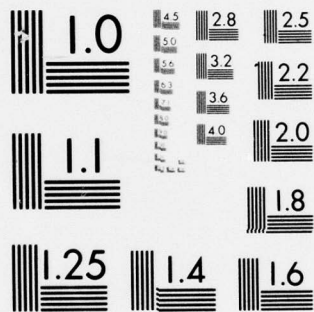
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RESEARCH AND DEVELOPMENT TECHNICAL REPORT
DELCS-TR-78-1

TESTS OF NEUTRON DOSIMETER, ADVANCED DEVELOPMENT
MODEL

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Ockle E. Johnson
Combat Surveillance & Target Acquisition Laboratory

387589

January 1978

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1. REPORT NUMBER 24 DELCS-TR-78-1	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 Tests of Neutron Dosimeter, Advanced Development Model	5. TYPE OF REPORT & PERIOD COVERED	
7. AUTHOR(s) 19 Ockle E. Johnson	6. PERFORMING ORG. REPORT NUMBER	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Radiac Division CS&TA Laboratory (ERADCOM) Fort Monmouth, NJ 07703 DELCS-K	8. CONTRACT OR GRANT NUMBER(s)	
11. CONTROLLING OFFICE NAME AND ADDRESS ERADCOM ATTN: DELCS-K Fort Monmouth, NJ 07703	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 16 1LT 62703 DH 93 RT 17	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	12. REPORT DATE 21 Jan 1978	
	13. NUMBER OF PAGES 20 13/26p.	
	15. SECURITY CLASS. of this report UNCLASSIFIED	
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE		
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited. PE 62703A AS H93		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Neutron Dosimeter, neutron diode, dosimeter, tactical dosimeter, nuclear radiation instrumentation.		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dosimeters were subjected to two types of tests to determine their accuracy and temperature response. They were exposed to 14 MeV neutrons from 31 rads to 781 rads with one exposure to 1880 rads to check the response to over exposure. The dosimeters passed all of these tests. In addition, the dosimeters were tested for temperature in the range from -40°C to +52°C. The dosimeters also passed all of these tests. Short term as well as long term annealing is observable in the data. Fluctuations of up to 18 rads → not pay		

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in the readings of dosimeters containing unexposed diodes were observed. Tests showed these fluctuations to be caused by the diodes and not by the dosimeter electronics or other dosimeter components. The fluctuations of the unexposed diodes were noted for the first time because of the superior dosimeter readout system.

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FOREWORD

The author wishes to acknowledge the assistance of J. Crotchfelt, M. Basso, E. Groeber, and B. Markow.

In addition, the author wishes to thank Dr. S. Kronenberg, Electronic Technology and Device Laboratory, for his cooperation in providing the use of the Fort Monmouth 14 MeV neutron generator at Sandy Hook, New Jersey, and for his many helpful suggestions.

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1. INTRODUCTION

Five portable battery-operated neutron dosimeter systems were obtained from RCA, Camden, New Jersey under contract with the US Army Electronics Command, Radiac Technical Area. The system employs a 50 mil PIN Detector Diode, whose forward voltage increases with exposure to fast neutrons. Because this change is permanent and cumulative, the system is able to integrate small doses (from 0 to 1000 rads) over long periods of time.

The system operates from -40°C to $+52^{\circ}\text{C}$ and is temperature compensated over this entire range. Accuracies of ± 20 rads for readings below 100 rads and ± 20 percent for readings above 100 rads are maintained throughout the range.

Temperature correction is performed digitally after an initial analog to digital conversion of both the forward diode voltage and the ambient temperature. System flexibility is promoted with the use of a replaceable Read Only Memory (ROM) for the final voltage to dose conversion table.

This digital approach to temperature compensation, combined with the extensive use of CMOS circuitry is to allow the use of large scale integration (LSI) as a means of reducing system size and weight.¹

2. DESCRIPTION OF DOSIMETER

The dosimeter is an electronic neutron dosimeter. Its dimensions are $9\frac{1}{2}'' \times 4\frac{1}{2}'' \times 2\frac{1}{2}''$ and it weighs $2\frac{1}{2}$ pounds. In the next model, it is expected that large scale integration (LSI) will be used. This technique could reduce the size of the electronics which is presently the bulk of the dosimeter to about one cubic inch and a couple of ounces. This would not include the batteries or the digital readout. The primary sensor is a neutron sensitive silicon diode. The calibration curve is programed into the dosimeter. A thermistor is included in the electronics and a temperature correction factor is also programed into the dosimeter because the silicon diode is temperature dependent. The dosimeter is battery powered and is read out by pressing a single button. The exposure dose is read in rads on a three digit LED display. The dose does not erase but accumulates with additional exposures. The neutron diode is held in place by two small clamps and may be replaced after exposure with a diode that reads zero.

An unexposed diode with precisely 100 milliamperes forward current has a voltage drop of about 0.908 ± 0.012 millivolt. For each calibration, each dosimeter has a set of six rocker switches which are used to obtain an initial reading of zero for any unexposed diode. For the first 100 rads of neutron dose, one rad of neutron dose increases the voltage by about one millivolt.

¹ ECOM 76-0896-F, Neutron Dosimeter Development Model, Final Report, July 1977, P. Ramondetta, Contract No. DAAB07-76-C-0896.

3. NEUTRON RADIATION TESTS

All of the five dosimeters were exposed at least once to the 14 MeV neutron generator facility of Fort Monmouth at Sandy Hook, New Jersey. Aluminum blocks were taped inside the dosimeter immediately over the neutron²sensitive diode in order to determine the actual dose delivered to the diode.

Two dosimeters were exposed to neutrons on 3 Aug 77 (see Tables 1 and 2). The first readings were taken 2 or 3 minutes after the exposure was completed. Additional readings were taken for the next few weeks.

Three dosimeters were exposed on 9 Aug 77 (see Tables 3 and 4). Readout procedures were as stated above. Dosimeter No. 1 was exposed to 1880 rads and read off scale (above 1000 rads). Readings of dosimeter No. 1 were taken until 11 Aug 77 when the diode was replaced so that the dosimeter could be retested.

Two dosimeters were exposed on 16 Aug 77 (see Tables 5 and 6). On 12 Aug 77 the diode from dosimeter No. 3 was replaced with a new diode. Dosimeter No. 3 had previously been exposed on 3 Aug 77 (see Table 2). As was explained in the last paragraph, dosimeter No. 1 was overexposed on 9 Aug 77 and retested.

It should be noted in Table 6 that the zero reading was 18 rads. The dosimeters had been zeroed two days before the test. I cannot explain why the zero reading shifted to 18 rads. The zero readings were taken after the aluminum blocks, covered with electrical tape, were taped over the diode. The electrical tape went over the electronics and was taped to the back of the dosimeter. It is doubtful that this caused the perturbation. A special zero drift test was performed (see Section 5).

The neutron radiation test results are shown in Tables 1 to 6 and all exceed the requirements of the specification. The specification accuracy requirement is ± 20 rads or ± 20 percent, whichever is greater. Figures 1 and 2 show the dosimeter readings below and above 100 rads, compared with the maximum error allowed, for all of the neutron exposures.

4. DIODE ANNEALING

The silicon diode neutron sensors have a tendency to anneal after exposure. The percent of annealing increases with increasing dose. The effects of short term (weeks) annealing may be observed in Tables 1 thru 6.

Long term annealing is shown in Table 7. The dosimeters were exposed on 20 Aug 75. They were read out in a laboratory set up on 15 Sep 75 and 29 Jul 77. In the laboratory set up, 100 milliamperes dc is passed through the diode

² ECOM-4323, Aluminum Threshold Dosimetry at the ECOM 14 MeV Neutron Irradiation Facility, S. Kronenberg et al. May 1975

and the diode voltage is read. It will be noted that the readings decreased slightly over the two year period. The diodes were then placed in the dosimeters and read. The close correspondence between the 29 Jul 77 laboratory readout and the 1 Aug 77 dosimeter readout will be noted.

Long term annealing is shown in Table 7. The dosimeters were exposed on 20 Aug 75. They were read out in a laboratory set up on 15 Sep 75 and 29 Jul 77. In the laboratory set up, 100 milliamperes dc is passed through the diode and the diode voltage is read. It will be noted that the readings decreased slightly over the two year period. The diodes were then placed in the dosimeters and read. The close correspondence between the 29 Jul 77 laboratory readout and the 1 Aug 77 dosimeter readout will be noted.

It is believed that the major source of error in the dosimeter is due to annealing, both short and long term. The reason for the long term annealing error is that the dosimeters were programed with the 15 Sep 75 laboratory data shown in Table 7.

5. TEMPERATURE TESTS

a. Temperature Tests With Batteries

The dosimeters were placed in a "Tenney 10" temperature chamber and allowed to stabilize for 1½ hours at each temperature. The dosimeters, using the built-in alkaline battery power supply, were tested from 0°C to +52°C. The results are shown in Table 8. The dosimeters exceeded the requirements of the specification.

b. Temperature Tests With Electronic Power Supply

The original concept was to have the dosimeters operate with batteries down to -40°C. However, since the batteries used would function only to 0°C, an electronic power supply had to be used to test the temperature dependence from 0°C to -40°C. The dosimeters were placed in a "Tenney 10" temperature chamber and allowed to stabilize for 1½ hours at each temperature. The results are shown in Table 9. The dosimeters exceeded the requirements of the specification.

6. ZERO DRIFT TEST

Because of the zero drift of 18 rads noted in Section 2 and Table 6, and because almost all of the other dosimeters had to be rezeroed after a few days drift, an experiment was initiated to determine the cause. Unexposed diodes were put into dosimeters No. 4 and 5 and the dosimeters were adjusted to read 11 rads. Readings were taken periodically and the results are shown in Tables 10 and 11. The stability was initially unsatisfactory.

All of the diodes used in all of the experiments described in this report, with the two exceptions noted in Tables 10 and 11, had been taped to 3 X 5

cards with pressure sensitive adhesive cellophane transparent tape. They had been taped for about four months for use in another experiment awaiting the repair of the 14 MeV neutron generator. By the time the generator was repaired the experiment was no longer needed.

Because of the shortage of diodes, these diodes were untaped and used in the experiments detailed in this report. Some of the glue probably adhered to the diode leads. It was common practice here to tape diodes to 3 X 5 cards for exposure and no difficulty had been noted in past laboratory experiments. However, these diodes were taped for an unusually long period of time and the dosimeter contacts differed from the laboratory contacts. The possibility also remains that the difficulty of drift from poor contact was present but not observed previously.

When the unsatisfactory drift showed up as reported in Tables 10 and 11 action was taken. The dosimeter diode terminals were cleaned with trichloroethane and the diodes were replaced with new, untaped diodes as noted in Tables 10 and 11. The drift immediately stopped in dosimeter No. 4 (Table 10) the dosimeter remained stable. However, I was unable to control the drift of dosimeter No. 5 (Table 11) in spite of the actions taken and recorded in Table 11.

It should be noted in Table 1 that the readings over a period of three weeks were 34 ± 2 rads. Table 2 shows readings of 62 ± 5 rads over a period of 8 days. Over 100 rads the dosimeter reads in steps of 10 rads. Table 3 shows, with the exception of the first reading, a reading of 130 ± 10 rads over a period of two weeks. The initial reading of 150 rads was taken just a few minutes after the end of the exposure. The change in dose from 150 at 11:42 to 140 at 11:47 was due to annealing, not drift. In Tables 4 thru 6, with initial readings of 380 rads, 610 rads, and 800 rads, the zero drift is completely masked by the annealing. The tables clearly show annealing to be large at high doses and small at low doses. The figures show the percent change due to annealing to be nearly equal with the exception of the 31 rad dose (Table 1) where annealing was not observed.

It must be recognized therefore that this drift may have been observed throughout the experimental data.

However, the annealing trends of the diodes, the tendency toward lower readings with time, are real properties of the diodes themselves and are not introduced by the tape.

Since cleaning the diode leads did not prevent the zero drift (see Table 11), a new approach was tried. The diodes in dosimeters No. 4 and No. 5 were exchanged (see Tables 12 and 13). It will be noted that the diode showed stability of ± 1 rad in Table 10 from 25 Aug 77 until 6 Sep 77 in dosimeter No. 4. This same diode showed stability of $\pm 1\frac{1}{2}$ rads in Table 13 from 6 Sep 77 until 19 Sep 77 in dosimeter No. 5.

Likewise, the diode which showed a lack of stability in Table 11, dosimeter No. 5 showed a similar lack of stability after the exchange as shown in Table 12, dosimeter No. 4. The diode exchange indicates that it is the diode which is the cause of zero drift and not the other electronic components of the dosimeters.

The diode in dosimeter No. 4 was replaced with a 9.17 ohm precision resistor. Between 21 Sep 77 and 30 Sep 77, fourteen readings were taken (see Table 14). Twelve of the readings were 58 rads while two of the readings were 57 rads. This test again indicates that the electronics and other components of the dosimeters are stable and that the zero drift is a property of the diodes.

7. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that all of the dosimeters successfully passed the neutron exposure tests. In addition, the dosimeters passed the temperature tests in the range from 0°C to +52°C with the alkaline battery power supply provided. However, from 0°C to -40°C it was necessary to use an external electronic power supply since these temperatures are below the range of the alkaline batteries. With the electronic power supply the dosimeters passed the temperature tests in the range from 0°C to -40°C. It is recommended that in the next procurement a power supply be provided which will cover the entire temperature range from -40°C to +52°C. If necessary, an ancillary cold temperature power supply could be provided.

Annealing is a well known inherent problem of neutron sensitive diodes. Observations were made during the test period. In addition, results of a previously performed two year annealing test on a similar batch of diodes were presented. However, a previously unobserved problem with the diodes was discovered. Unexposed diodes had a tendency to drift as much as 18 rads. It is recommended that this problem be further investigated.

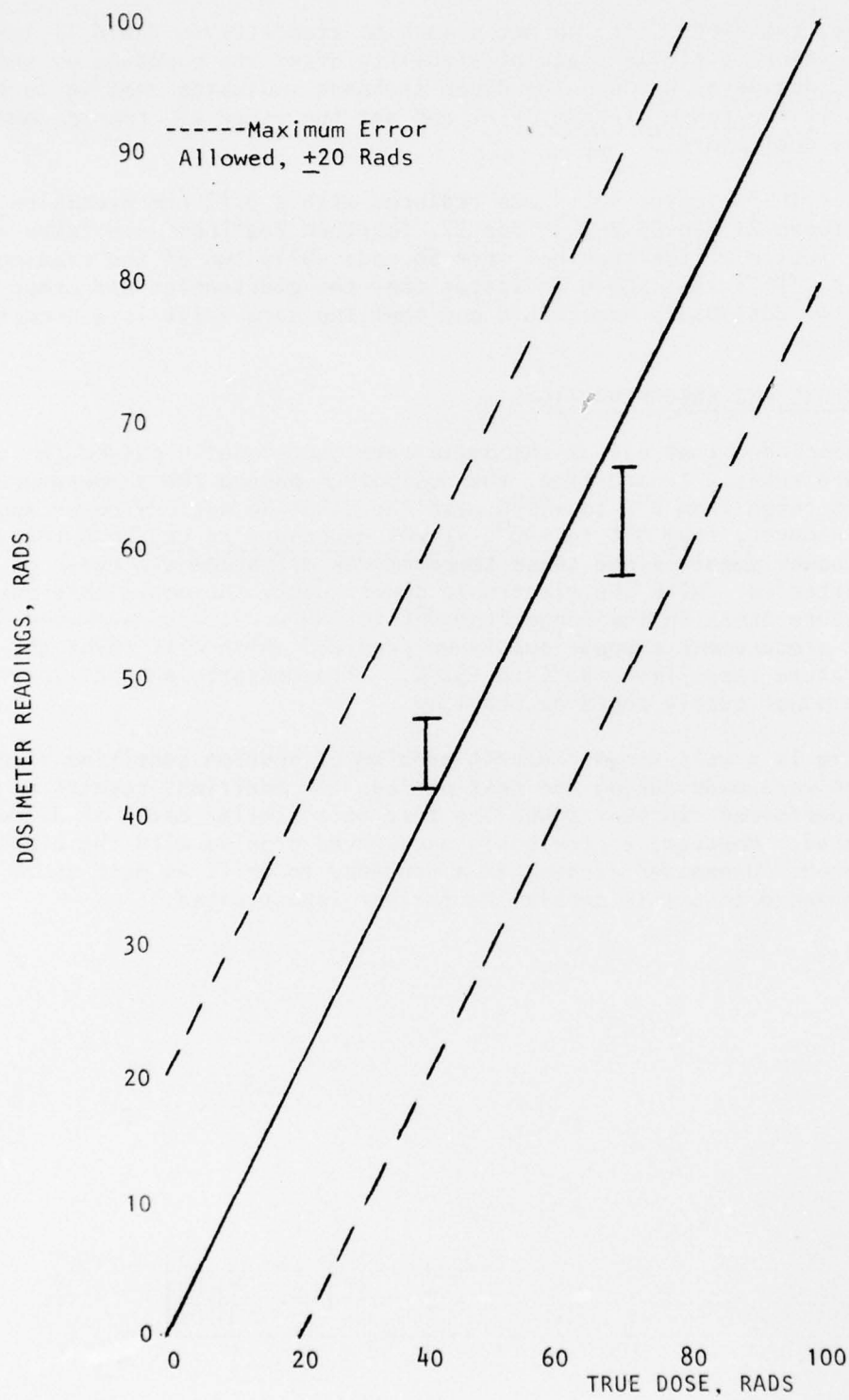


Figure 1. Dosimeter Readings Below 100 Rads Compared with Maximum Error Allowed.

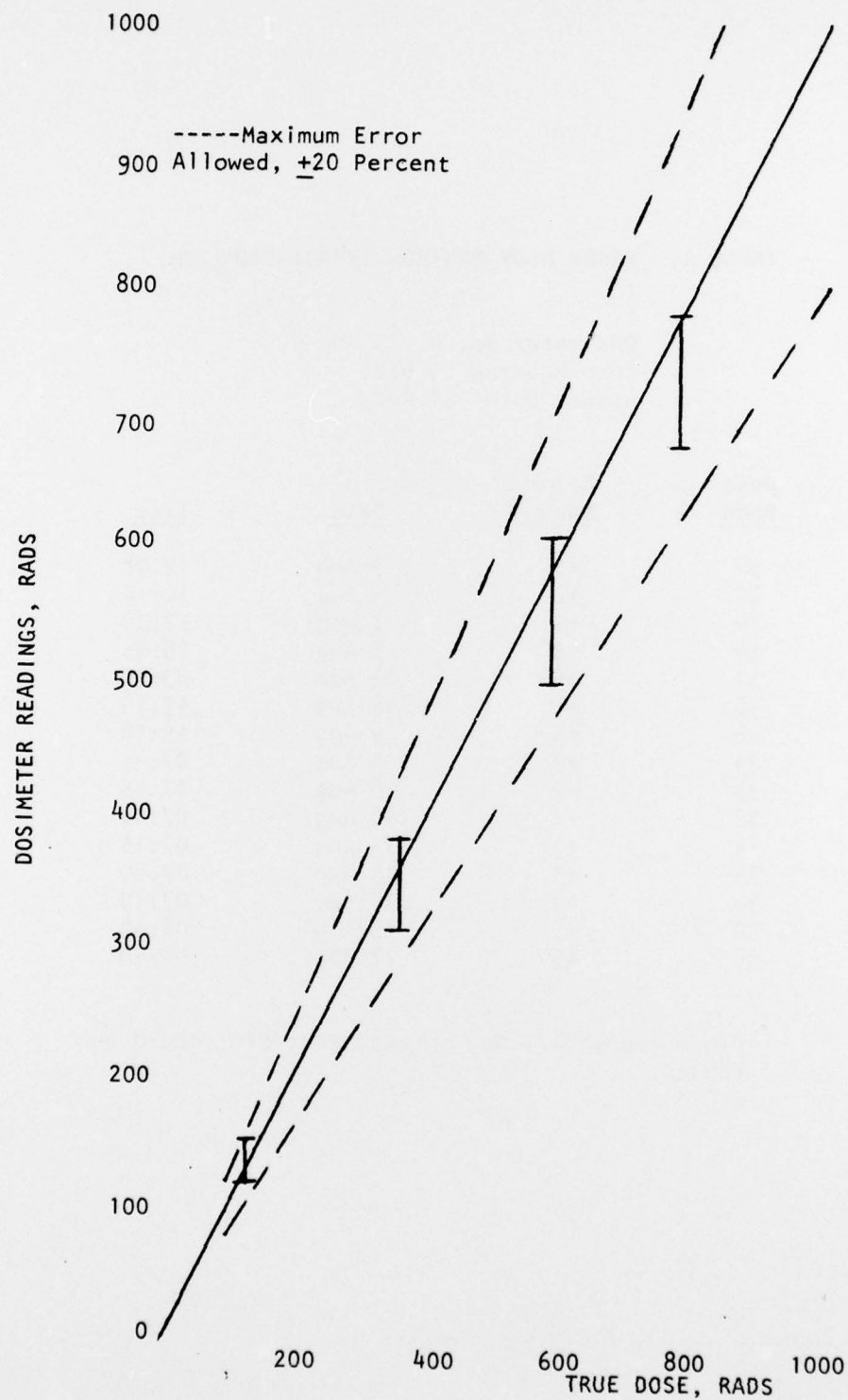


Figure 2. Dosimeter Readings Above 100 Rads Compared with Maximum Error Allowed.

TABLE 1. SANDY HOOK NEUTRON IRRADIATION NO. 1

Dosimeter No. 4, 3 Aug 77
 Zero Reading 0 Rads
 Actual Dose 31 Rads

<u>Dose Rads</u>	<u>Error Rads</u>	<u>Date</u>	<u>Time</u>
34	+3	3 Aug	12:08
33	+2	3 Aug	12:10
34	+3	3 Aug	13:20
34	+3	3 Aug	15:45
37	+6	4 Aug	09:00
36	+5	4 Aug	13:15
36	+5	4 Aug	15:30
34	+3	5 Aug	07:45
33	+2	8 Aug	07:45
32	+1	10 Aug	07:40
34	+3	11 Aug	07:15
34	+3	15 Aug	07:40
34	+3	17 Aug	07:10
36	+5	19 Aug	06:40
36*	+5*	22 Aug	07:40

*Diode removed 23 Aug so that dosimeter could be reused.

TABLE 2. SANDY HOOK NEUTRON IRRADIATION NO. 2

Dosimeter No. 3, 3 Aug 77
 Zero Reading 0 Rads
 Actual Dose 70 Rads

<u>Dose</u> <u>Rads</u>	<u>Error</u> <u>Rads</u>	<u>Date</u>	<u>Time</u>
66	- 4	3 Aug	12:09
65	- 5	3 Aug	12:10
65	- 5	3 Aug	13:20
65	- 5	3 Aug	15:45
60	-10	4 Aug	09:00
64	- 6	4 Aug	13:15
60	-10	4 Aug	15:30
63	- 7	5 Aug	07:45
58	-12	8 Aug	07:45
57	-13	8 Aug*	09:30
63	- 7	8 Aug*	09:40
60	-10	10 Aug	07:40
60	-10	11 Aug*	07:15
61**	- 9**	11 Aug*	14:00

*Batteries removed and replaced.

**Diode removed 12 Aug so that the dosimeter could be reused.

TABLE 3. SANDY HOOK NEUTRON IRRADIATION NO. 3

Dosimeter No. 5, 9 Aug 77
 Zero Reading 5 Rads
 Actual Dose 131 Rads

<u>Dose</u> <u>Rads</u>	<u>Error</u> <u>Rads</u>	<u>Date</u>	<u>Time</u>
150	+15	9 Aug	11:42
140	+ 7	9 Aug	11:47
140	+ 7	9 Aug	13:05
140	+ 7	9 Aug	14:30
130	- 1	10 Aug	07:40
130	- 1	11 Aug*	07:15
120	- 8	15 Aug	07:45
140	+ 7	17 Aug	07:10
120	- 8	19 Aug	06:40
130**	- 1**	22 Aug	07:40

*Batteries removed and replaced 11 Aug 77

**Diode removed 23 Aug so that the dosimeter could be reused.

TABLE 4. SANDY HOOK NEUTRON IRRADIATION NO. 4

Dosimeter No. 2, 9 Aug 77
Zero Reading 4 Rads
Actual Dose 355 Rads

<u>Dose</u> <u>Rads</u>	<u>Error</u> <u>Percent</u>	<u>Date</u>	<u>Time</u>
380	+ 7	9 Aug	11:42
370	+ 4	9 Aug	11:47
350	- 1	9 Aug	13:05
360	+ 1	9 Aug	14:30
350	- 1	10 Aug	07:40
340	- 4	11 Aug	07:15
320	-10	15 Aug	07:45
330	- 7	17 Aug	07:10
320	-10	19 Aug	06:35
310	-13	22 Aug	07:40
310	-13	24 Aug	07:30
310	-13	26 Aug	07:30
310	-13	29 Aug	07:40
310	-13	31 Aug	07:40
300	-15	2 Sep	07:45
310	-13	6 Sep	08:05
310	-13	7 Sep	07:45
310	-13	9 Sep	07:50
310	-13	12 Sep	07:55
310	-13	14 Sep	08:05
310	-13	16 Sep	07:50
310	-13	19 Sep	08:55
310	-13	21 Sep	07:50
310	-13	23 Sep	07:40
310	-13	26 Sep	10:30
310	-13	27 Sep	07:45
310	-13	28 Sep	07:45
310	-13	30 Sep	07:50

TABLE 5. SANDY HOOK NEUTRON IRRADIATION NO. 5

Dosimeter No. 3, 16 Aug 77
 Zero Reading 4 Rads
 Actual Dose 584 Rads

<u>Dose</u> <u>Rads</u>	<u>Error</u> <u>Percent</u>	<u>Date</u>	<u>Time</u>
610	+ 4	16 Aug	11:30
590	+ 1	16 Aug	13:00
590	+ 1	16 Aug	14:05
580	- 1	16 Aug	16:25
580	- 1	17 Aug	07:10
560	- 4	17 Aug	15:20
550	- 6	18 Aug	07:00
560	- 4	19 Aug	06:35
550	- 6	22 Aug	07:40
540	- 8	24 Aug	07:30
530	- 9	26 Aug	07:30
530	- 9	29 Aug	07:40
520	-11	31 Aug	07:40
520	-11	2 Sep	07:45
510	-13	6 Sep	08:05
510	-13	7 Sep	07:45
510	-13	9 Sep	07:50
510	-13	12 Sep	07:55
510	-13	14 Sep	08:05
510	-13	16 Sep	07:50
510	-13	19 Sep	08:55
500	-14	21 Sep	07:50
510	-13	23 Sep	07:40
500	-14	26 Sep	10:30
510	-13	27 Sep	07:45
500	-14	28 Sep	07:45
500	-14	30 Sep	07:50

TABLE 6. SANDY HOOK NEUTRON IRRADIATION NO. 6

Dosimeter No. 1, 16 Aug 77
 Zero Reading 18 Rads
 Actual Dose 781 Rads

<u>Dose Rads</u>	<u>Net Dose* Rads</u>	<u>Error Percent</u>	<u>Date</u>	<u>Time</u>
800	780	0	16 Aug	11:30
770	750	- 4	16 Aug	13:00
760	740	- 5	16 Aug	14:05
760	740	- 5	16 Aug	16:25
750	730	- 7	17 Aug	07:10
750	730	- 7	17 Aug	15:20
740	720	- 8	18 Aug	07:00
730	710	- 9	19 Aug	06:35
710	690	-12	22 Aug	07:40
700	680	-13	24 Aug	07:30
690	670	-14	26 Aug	07:30
690	670	-14	29 Aug	07:40
680	660	-15	31 Aug	07:40
680	660	-15	2 Sep	07:45
670	650	-17	6 Sep	08:05
670	650	-17	7 Sep	07:45
670	650	-17	9 Sep	07:50
670	650	-17	12 Sep	07:55
670	650	-17	14 Sep	08:05
660	640	-18	19 Sep	08:55
660	640	-18	21 Sep	07:50
660	640	-18	23 Sep	07:40
660	640	-18	26 Sep	10:30
660	640	-18	27 Sep	07:45
660	640	-18	28 Sep	07:45
660	640	-18	30 Sep	07:50

*For the net dose in rads, 20 rads is subtracted from the dose in rads to account for the 18 rad zero reading.

TABLE 7. LONG TERM DIODE ANNEALING

15 Sep 75 Lab Read Dose Rads	29 Jul 77 Lab Read Dose Rads	Change In 2 Years Dose Rads	Dosimeter No.	1 Aug 77 Dosimeter Dose Rads	Change In 2 Years Dose Rads
28	28	0	1	34	+6
94	92	-2	2	96	+2
		Change In 2 Years Percent			Change In 2 Years Percent
380	365	-4	3	360	-5
620	570	-8	4	560	-10
1070	1010	-6	5	980	-8

TABLE 8. TEMPERATURE TESTS WITH BATTERIES

Dosimeter No. 2, 10 Aug 77

Temperature °C	Dose Rads	Error Percent
24	350	0
52	330	-6
0	350	0

Dosimeter No. 3, 10 Aug 77

Temperature °C	Dose Rads	Error Percent
24	57	0
52	68	+11
0	57	0

TABLE 9. TEMPERATURE TESTS WITH ELECTRONIC POWER SUPPLY

Dosimeter No. 2, 11 Aug 77

<u>Temperature °C</u>	<u>Dose Rads</u>	<u>Error Percent</u>
+25	340	0
-28	350	+3
-40	350	+3
-20	350	+3
- 5	350	+3
25	340*	0

Dosimeter No. 3, 11 Aug 77

<u>Temperature °C</u>	<u>Dose Rads</u>	<u>Error Rads</u>
+25	60	0
-28	43	-17
-40	46	-14
-20	43	-17
- 5	58	- 2
25	61*	1

*Dose after replacing batteries.

TABLE 10. ZERO DRIFT CHECK NO. 1

Dosimeter No. 4, 23 Aug 77
First Reading, 11 Rads

<u>Reading Rads</u>	<u>Error Rads</u>	<u>Date</u>	<u>Time</u>
11	0	23 Aug	10:30
9	- 2	23 Aug	12:45
0	-11	23 Aug	15:35
8	- 3	24 Aug	07:30
4	- 7	24 Aug	11:05
Below 0	Unknown	24 Aug	15:30
Below 0	Unknown	25 Aug	07:40
24*	0*	25 Aug	08:30
25	+ 1	25 Aug	11:00
24	0	25 Aug	15:30
24	0	26 Aug	07:30
24	0	26 Aug	11:05
23	- 1	26 Aug	15:35
24	0	29 Aug	07:40
24	0	30 Aug	07:35
24	0	31 Aug	07:40
24	0	1 Sep	08:05
24	0	2 Sep	07:45
25	+ 1	6 Sep	08:05

*Dosimeter diode terminals cleaned with trichloroethane and diode replaced with new untaped diode.

TABLE 11. ZERO DRIFT CHECK NO. 2

Dosimeter No. 5, 23 Aug 77
First Reading, 11 Rads

<u>Reading Rads</u>	<u>Error Rads</u>	<u>Date</u>	<u>Time</u>
11	0	23 Aug	10:30
15	+ 4	23 Aug	12:45
9	- 2	23 Aug	15:35
5	- 6	24 Aug	07:30
8	- 3	24 Aug	11:05
12	+ 1	24 Aug	15:30
11	0	25 Aug	07:40
12	+ 1	25 Aug	11:00
11	0	25 Aug	15:30
14	+ 3	26 Aug	07:30
12*	+ 1*	26 Aug	08:15
2*	- 9*	26 Aug	11:05
11	0	26 Aug	11:20
0	-11	26 Aug	12:50
14**	0**	26 Aug	15:35
14	0	29 Aug	07:40
14	0	30 Aug	07:35
15	+ 1	31 Aug	07:40
2	-13	1 Sep	08:05
20***	0	1 Sep	10:30
18	- 2	1 Sep	11:15
8	-12	1 Sep	13:00
9	-11	1 Sep	16:30
8	-12	2 Sep	07:45
11	- 9	2 Sep	11:30
8	-12	6 Sep	08:05

*Dosimeter diode terminals and diode leads cleaned
with trichloroethane.

**Diode replaced with new untaped diode.

***Dosimeter diode terminals cleaned with trichloro-
ethane and diode replaced with new untaped diode.

TABLE 12. ZERO DRIFT CHECK NO. 3

Dosimeter No. 4, 6 Sep 77
First Reading, 12 Rads

<u>Reading Rads</u>	<u>Error Rads</u>	<u>Date</u>	<u>Time</u>
12*	0	6 Sep	10:50
12	0	6 Sep	11:30
12	0	6 Sep	13:00
12	0	6 Sep	15:10
14	+ 2	6 Sep	16:15
24	+12	7 Sep	07:45
25	+13	7 Sep	16:00
14	+ 2	8 Sep	07:55
18**	0	8 Sep	11:15
21	+ 3	8 Sep	13:00
23	+ 5	8 Sep	14:25
12	0	9 Sep	07:50
21***	0	9 Sep	08:40
21	0	9 Sep	09:45
21	0	9 Sep	15:45
12	- 9	12 Sep	07:55
11	-10	13 Sep	08:15
9	-12	14 Sep	08:05
11	-10	15 Sep	07:55
11****	-10	16 Sep	07:50

*Diodes in dosimeters No. 4 and No. 5 reversed
10:50, 6 Sep 77 (See Tables 10, 11, 12 and 13).

**New diode; varnish scraped off leads with razor blade.

***Diode twisted in terminals and centered.

****Diode removed 16 Sep 77 for precision resistor test.

TABLE 13. ZERO DRIFT CHECK NO. 4

Dosimeter No. 5, 6 Sep 77
First Reading, 11 Rads

<u>Reading Rads</u>	<u>Error Rads</u>	<u>Date</u>	<u>Time</u>
11*	0	6 Sep	10:50
11	0	6 Sep	11:30
11	0	6 Sep	13:00
12	+ 1	6 Sep	15:10
12	+ 1	6 Sep	16:15
11	0	7 Sep	07:45
11	0	7 Sep	16:00
11	0	8 Sep	07:55
11	0	9 Sep	07:50
14	+ 3	12 Sep	07:55
12	+ 1	13 Sep	08:15
11	0	14 Sep	08:05
12	+ 1	15 Sep	07:55
14	+ 3	16 Sep	07:50
11	0	19 Sep	08:55
9	- 2	20 Sep	07:50
14	+ 3	21 Sep	07:50
14	+ 3	22 Sep	07:40
15	+ 4	23 Sep	07:40
17	+ 6	26 Sep	10:30
15	+ 4	27 Sep	07:45
15	+ 4	28 Sep	07:45
17	+ 6	29 Sep	07:40
15	+ 4	30 Sep	07:50

*Diodes in dosimeters No. 4 and No. 5 reversed
10:50, 6 Sep 77 (See Tables 10, 11, 12 and 13).

TABLE 14. ZERO DRIFT CHECK NO. 5

Dosimeter No. 4, 21 Sep 77
First Reading, 58 Rads

<u>Reading Rads</u>	<u>Error Rads</u>	<u>Temperature °C</u>	<u>Date</u>	<u>Time</u>
58*	0	23.2	21 Sep	07:50
58	0	23.8	21 Sep	11:10
58	0	24.0	21 Sep	16:00
58	0	22.7	22 Sep	07:40
57	- 1	23.5	22 Sep	11:10
58	0	23.4	22 Sep	16:15
57	- 1	22.5	23 Sep	07:40
58	0	23.6	23 Sep	15:35
58	0	22.5	24 Sep	10:00
58	0	22.3	26 Sep	10:30
58	0	22.6	27 Sep	07:45
58	0	22.4	28 Sep	07:45
58	0	22.0	29 Sep	07:40
58	0	22.3	30 Sep	07:50

*Diode removed 16 Sep 77 for precision resistor test.
Diode replaced with 9.17 ohm resistor.